


# Experimental Design

How to conduct a valid experiment.



# A Good Experiment

- Tests one variable at a time. If more than one thing is tested at a time, it won't be clear which variable caused the end result.
- Must be fair and unbiased. This means that the experimenter must not allow his or her opinions to influence the experiment.
- Does not allow any outside factors to affect the outcome of the experiment.

# A Good Experiment

- Is **valid**. The experimental procedure must test your hypothesis to see if it is correct.
- If the procedure does not test your hypothesis, the experiment is not valid and the data will make no sense!
- Has **repeated trials**. Repeating the trials in the experiment will reduce the effect of experimental errors and give a more accurate conclusion.

# Variables

- A variable is anything in an experiment that can change or vary.
- It is any factor that can have an effect on the outcome of the experiment.
- There are three main types of variables.

## 3 Kinds of Variables

### Independent Variable (IV)

- something that is intentionally changed by the scientist
  - What is tested
  - What is manipulated
  - Also called a “Manipulated Variable”
  - You can only change ONE variable in an experiment!!!

# 3 Kinds of Variables

## Independent Variable (IV)

To determine the independent variable, ask yourself:

*“What is being changed?”*

Finish this sentence...

*“I will change the \_\_\_\_\_”*

# Independent Variable

## Levels of the IV

- These are different ways you will change the independent variable

*Example:* Assume you are testing five brands of popcorn to see which has the most unpopped kernels.

- The IV would be the different brands of popcorn.
- The five different brands would be the different levels of the IV.

## 3 Kinds of Variables

### Dependent Variable (DV)

- something that might be affected by the change in the independent variable
  - What is ***observed and measured***
  - The data collected during the investigation
  - Also called a “Responding Variable”



# 3 Kinds of Variables

## Dependent Variable (DV)

To determine the dependent variable, ask yourself:

*“What will I measure and observe?”*

Finish this sentence...

*“I will measure and observe \_\_\_\_\_”*

# Dependent Variable

## Operational Definition:

- Define exactly how the dependent variable will be measured.

*Example: Assume your DV in an experiment is “plant growth.” How will you measure this?! It could be...*

- *Height (cm), mass (g), # of leaves, etc.*
- *Be specific and include all necessary units!*

## 3 Kinds of Variables

### Controlled Variable (CV)

- a variable that is not changed and kept the same
  - Also called constants
  - Allows for a “fair test”
  - **NOT** the same as a “control”!!
  - Any given experiment will have many controlled variables

## 3 Kinds of Variables

### Controlled Variable (CV)

To determine the controlled variables, ask yourself:

*“What should not be allowed to change?”*

Finish this sentence...

*“I will not allow the \_\_\_\_\_ to change.”*

# Control

A group or individual in the experiment that is not tested, but is used for comparison as a reference for what “normal” would be like.

- Not all experiments have a control (though all experiments have controlled variables).

*Example:* If you tested different pollutants to see their affect on plant growth, the control would only receive water.

# Sample Data Table

**Title:** The Effect of *the independent variable* on the *dependent variable*

Column for <i>independent variable</i>	Column for <i>dependent variable</i>			Column for derived <i>quantity</i>
Label – with units if necessary	Label – with units if necessary – multiple trials included			Label – with units if necessary. Example = average of trials
	1	2	3	

# Graphs

**Title:** The Effect of *the independent variable* on the *dependent variable*

**Dependent Variable –**  
include units and an  
appropriate scale

**Independent Variable – include**  
units and an appropriate scale

**Here are some different examples:**





Students of different ages were given the same jigsaw puzzle to put together.

They were timed to see how long it took to finish the puzzle.



**Identify the variables in this investigation!**



# What was the independent variable?

Ages of the students

- Different ages were tested by the scientist

## What was the dependent variable?

The time it to put the puzzle together

- The time was observed and measured by the scientist

# What was a controlled variable?

## Same puzzle

- All of the participants were tested with the **same** puzzle.
- It would not have been a fair test if some had an easy 30 piece puzzle and some had a harder 500 piece puzzle.

**Another example:**



**What are the variables in this investigation?**



The temperature of water was measured at different depths of a pond.





- **Independent variable** – depth of the water
- **Dependent variable** – temperature
- **Controlled variables** – same pond; same thermometer